MSNE 650 – Advanced Topics on Nanomaterials and Nanomechanics

Spring, 2019 Lecture: T, Th 1:00-2:15pm, HBH 423

Course instructors: Dr. Jun Lou (jlou@rice.edu), MEB 223, x3573

Synopsis:

The primary goal of this course is to introduce important current developments in the field of nanomaterials and nanomechanics to graduate students. The emerging nanotechnology critically depends on our ability to develop new nanomaterials, understand their corresponding behaviors and employ them to gain new functionalities at different length scales. This course will discuss synthesis and characterization of nanomaterials, the behaviors especially mechanical behaviors in the broad sense of such materials, and their technological applications. The basic physics and fundamental mechanisms responsible for nanoscale-induced changes in properties will be addressed.

The course is organized in a seminar format. The plan is to blend introductory and in-depth lectures with student presentations on recent scientific papers of interests to this class. Generally, student will get copies of the relevant article(s) for the chosen topic, and give a presentation describing the work.

A research proposal will be included to provide students with an opportunity to explore a nanotechnology topic of their interest. This is to give graduate students training on important grant writing skills. A guideline will be provided later in the semester for the proposal writing and a mock panel review will be organized by the instructor to provide both feedbacks on the technical content and first-hand experiences on proposal evaluations. Finally, students will be required to write a maximum 10-page (font size 11-12, single spaced, excluding abstract and references) term paper on **RELATED** topics of their interests or their own research work.

Textbook:

None. Reading assignments/papers will be given.

References:

Synthesis and Fabrication

M.J. Madou, *Fundamentals of Microfabrication*, CRC Press.

G. Cao, *Nanostructures and Nanomaterials*, Imperial College Press

M. Ohring, *Materials Science of Thin Films*, Academic Press

Mechanics of Nanomaterials

L.B. Freund and S. Suresh, *Thin Film Materials: Stress, Defect Formation and Surface Evolution*, Cambridge University Press

MEMS/NEMS:

M. Gad-el-Hak, *The MEMS Handbook*, CRC Press.

A.N. Cleland, *Foundations of Nanomechanics*, Springer.

Nanocomposites/Composites Theories:

P.M. Ajayan, L.S. Schadler and P.V. Braun, *Nanocomposite Science and Technology*, Wiley-VCH

M. Taya, *Electronic Composites*, Cambridge University Press

Adhesion and Friction:

J. Isarelachvili, *Intermolecular & Surface Forces*, Academic Press
B.N.J. Persson, *Sliding Friction*, Springer

Microscopy Methods

P.J. Goodhew, J. Humphreys and R. Beanland, *Electron Microscopy and Analysis*, Taylor & Francis Group
D.B. Willams and C.B. Carter, *Transmission Electron Microscopy,* Springer
J. Goldstein et al., *Scanning Electron Microscopy and X-Ray Microanalysis*, Springer
R. Wiesendanger, *Scanning Probe Microscopy and Spectroscopy*, Cambridge University Press
P. Hirsch, *Electron Microscopy of Thin Crystals*, Krieger Publishing Company

Carbon Nanotubes

R. Saito, G. Dresselhaus and M.S. Dresselhaus, *Physical Properties of Carbon Nanotubes*, Imperial College Press

Proposal writing:

http://www.research.pitt.edu/selected-proposal-writing-resources

Office Hours

Please stop by anytime when my office door is open. Or you can send me an email to make an appointment.

Grading:

Proposal **30%**, Term paper **30%**, and Oral Presentations **30%** and Participation **10%**

Student Oral Presentation Attendance Policy

1) If you miss one session, 2% will be subtracted from your participation grade;
2) If you miss two sessions, 5% will be subtracted from your participation grade;
3) If you miss three or more sessions, all participation grade (10%) will be subtracted.

Website of the course:

Go to https://canvas.rice.edu
Sign in use your NetID and password. Go to the "MSNE 650 001 Sp18" panel on your dashboard to access course information.

Term Paper Guidelines:

Reports of scientific and engineering studies, either experimental or theoretical, tend to follow a fairly set pattern. The following outline need not be followed exactly, however since it is quite standard, it is a good form to use.

TITLE: Make sure that the title contains key words that will clearly indicate the subject of the paper or report.

ABSTRACT: The abstract should be short, one or two paragraphs that give a brief statement of what was done and what the most important results and conclusions were.

INTRODUCTION: This section gives the necessary background information for the reader to understand the Results and Discussion sections that are to follow. It often explains the technological or scientific motivations for undertaking the study in the first place. The Introduction may give a review of the subject of the paper or report. Also it is quite proper to divide the Introduction into several separately subtitled Parts if several distinct topics are treated.

EXPERIMENTAL/SIMULATION/THEORETICAL METHODS: This should make it reasonably clear to a reader how he or she could reproduce your experiment/simulation/theories. If it is appropriate to the experiment/simulation, the accuracy of the experimental/simulation data should be discussed, e.g., the accuracy of the lattice parameter measurement in an electron beam diffraction experiment.
RESULTS: This section should be a neat, easily understood presentation of your experimental results. It should only include relevant raw data or data reduced to their most significant form. Generally, Results would be the place to put photomicrographs. Whenever tests are repeated, be sure to unambiguously identify which data are included in the report.
DISCUSSION (of Results): This section need not be separate; often it is better to combine the two, particularly where several different kinds of data are reported.
CONCLUSIONS: It is usually appropriate for an engineering report or scientific paper that deals with a complex subject with several points to be itemized as separate conclusions.
REFERENCES: This is a very important section. Generally it is best to cite authors' names, title, journal, volume, date, and page. List all references cited in the report text at the end in a separate section. Don't list references as footnotes.
APPENDIX: This is a catch-all section that can contain anything that might be of interest to some readers. It is appended to the main body of the report. Such things as detailed descriptions of specialized experimental techniques or apparatus, computer programs, involved theoretical developments or tabulated data. If you have something that might be of interest to some readers but would tend to distract others from your main theme, put it in the appendix.
FIGURES AND DIAGRAMS: These may appear in several sections of the main body of the paper or report - Introduction, Results, and Discussion. Make sure that each figure is numbered and has a brief descriptive caption. Graphs must be clearly labeled as to units. Remember that pictures and plots in a paper or report may be read by some readers who have not read the text. Therefore, as much as possible, figures should be labeled and captioned to convey information in a self-contained way.

General Notes

All technical reports should be typed, not hand written. Make sure your paper is neat, clear, as brief as possible, but complete. Don't be afraid to repeat important things, e.g., your main points could be repeated in more or less detail in the Abstract, Results, Discussion, and Conclusions sections.

Oral Presentation Guidelines:

At least one oral presentation is required for each student. The presentation is around 25 minutes (including Q&A and discussions, subject to change pending final student counts in class) and with ppt slides. Please address the following questions in your presentations:

- Background introduction
- What is new about this work (why hasn't this been done before) or what is the significant improvement if the work is incremental?
- What is the main experimental/theoretical method used?
- What are the achievements and impacts? i.e. What do we know now that we didn't know before this work?
- What are the limitations of the work and what are the next logical steps?

Papers of relevant discussion topics will be given to presenting students at least 2 weeks before the presentation.

About the Proposal:
A detailed instruction (A "Call for Proposal") will be provided later in the semester with detailed logistic requirements for developing your proposal. However, the students are encouraged to develop their ideas early in the semester. A lecture on grant writing will also be given to provide additional guidance. Finally, a mock panel review session will be organized in the last weeks of the semester and the students will get chance to review and comment on proposals from their peers.

Student with Disabilities
Any student with a disability requiring accommodations in this course is encouraged to contact me after class or during office hours. Additionally, students should contact Disabled Student Services at the Ley Student Center.